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Prediction of the tendency of Fort Dodge Junior High School students to matriculate in college

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PREDICTION OF THE TENDENCY OF FORT DODGE JUNIOR HIGH SCHOOL STUDENTS TO MATRICULATE IN COLLEGE

by

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I. INTRODUCTION

The prediction of formal educational continuation is receiving increasing attention in the educational field. Educators are finding that there is a need for teaching our youth to find their place in the pattern of American life, in addition to preparing them for higher education.

Proper guidance in the junior high school can do much toward building the educational program best suited for an individual. Guidance counselors need instruments that will help them determine the future needs of an individual, so that they may be of greater assistance in adapting an educational program to the student.

The purpose of this study is to build a predictive instrument that, in the hands of a guidance counselor, might help the student to find his place in our great American society.

The data for this study were collected from the Fort Dodge High School records, telephone conversations, questionnaires, and personal interviews.

The prediction variables used in this study were intelligence quotients and ninth grade mark averages. The intelligence quotient was obtained from the Otis Self-Administering Test of Mental Ability.

Based upon the information obtained, a prediction of the probability of educational continuation was made.

A. Delimitations

There are several variables that could be used in the prediction of formal educational continuation. However, for the purposes of this study the variables were limited to the intelligence quotients and the ninth grade mark averages as measures of academic aptitude and academicability.

II. REVIEW OF LITERATURE

In reviewing the literature, very little research was noted dealing specifically with the prediction of college matriculation using characteristics of high school freshman students as prediction variables. However, several related studies were reviewed in which the investigators were interested in predicting educational continuation.

Kessler[1] made a study concerning college matriculation of graduates of several small Central Iowa high schools. The high schools were primarily rural with a mean enrollment of 74 pupils. Students involved in this study were those who graduated during the years 1946 through 1950. Complete records were available for 290 of these students. Of the 290 pupils, 84 attended college.

The prediction variables used in the statistical treatment were I.Q., high school average, and economic status. The school administrators classified the parents as to economic status.

The following biserial r values were found for each of the variables.

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[1]Kessler, Kenneth William. Forecasting Probability of College Matriculation for Graduates of Small Central Iowa High Schools. Unpublished M.S. Thesis. Ames, Iowa, Iowa State College Library. 1951.

Intelligence Quotient	0.4700
High School Average	0.6395
Economic Status	0.6338

All values were found to be highly significant.

To determine the relationship between the dichotomy and the three variables, a multiple biserial R was computed. This value was found to be 0.7911, which is significant beyond the 1 per cent level.

In computing the relative importance of each variable, Keesler found the I.Q. to be the least effective in forecasting college matriculation. He also noted that when this variable was eliminated from the discriminant function the loss was not significant. Due to the relative unimportance of this variable, a probability statement was made by using the high school average and the economic status.

In another section of his study, an attempt was made to determine if there was a difference in the characteristics of those graduates entering state colleges and those entering private colleges. It was found that the I.Q., the high school average, and the economic status failed to make such a differentiation.

A similar study was made by Cosby[1]. He employed the same statistical treatment, except he did not attempt to

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[1] Cosby, Clifford Wayne. Weighting of Characteristics of High School Graduates for Determining Probability of Entrance to College. Unpublished M.S. Thesis. Ames, Iowa, Iowa State College Library. 1950. p. 22.

differentiate between the students entering private or State Colleges. The same variables were used in the prediction scheme.

The cases studied in this investigation were also graduates of small Iowa high schools. The schools were located in Moulton and Bloomfield, Iowa. These towns are located in southeastern Iowa.

A multiple biserial R of 0.5086 was computed by Cosby, whereas Kessler obtained a multiple biserial R of 0.7911.

Cosby also found that it was unnecessary to assemble intelligence quotients whenever suitable measures of the economic status and high school grade averages were available for predicting the probability of the high school graduates who will enter college.

Grigg[1] conducted a study concerning the attrition-survival of 248 boys entering the ninth grade in McKinley High School in Cedar Rapids, Iowa, during the period September 1943 through June 1947. Of these 248 boys, 70 had dropped out of school and 178 had graduated by June 15, 1951.

The data for each pupil were collected from the McKinley High School permanent record cards. The data taken were: withdrawn or graduated from school, intelligence quotient,

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[1]Grigg, Leslie R. Forecasting High School Graduation at the Ninth Grade Level in the McKinley High School at Cedar Rapids. Unpublished M.S. Thesis. Ames, Iowa, Iowa State College Library. 1951. p. 15.

age at the time of enrollment in the ninth grade, and the eighth grade school marks.

The three foregoing variables were used in the discriminant function to predict the pupil mortality tendency in the high school.

The following biserial r values were found:

Intelligence Quotient	0.3061
Ninth Grade Entrance Age	-0.4775
Eighth Grade mark average	0.5230

A multiple biserial correlation of 0.6029 was found for the three variables.

He found that the elimination of the intelligence quotient did not result in a significant loss to the predictive value of the other two variables. A discriminant function was then obtained using ninth grade entrance age and eighth grade mark average, to predict the chances in 100 of a student graduating from high school.

The study revealed that for the youngest pupil with the highest eighth grade mark average, the chances in 100 of graduating would be 97, whereas for the oldest pupil with the lowest mark average, the chances in 100 of graduating would be 32.

Herdman[1] made an investigation of 283 boys of the

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[1]Herdman, Raymond W. Predicting Pupil Mortality Among High School Boys. Unpublished M.S. Thesis. Ames, Iowa, Iowa State College Library. 1949. p. 12.

Wethersfield Township, Illinois, High School. He found that 71 of the boys withdrew from the school and 212 graduated. The boys entered high school during the years 1934 through 1944.

In comparing seven variables with the withdrawal and graduating groups, he found six to be significant. The seven variables were, (1) elementary school grade averages, (2) high school entrance age, (3) I.Q., (4) per cent of days absent, (5) high school grade average, (6) industrial arts grade average, and (7) father's occupation. The variable with the nonsignificant difference was the one concerning the father's occupation.

Herdman[1] employed the discriminant function to determine the best weights to be assigned to the variables for producing the maximum separation between the mortality and graduate groups. The variables selected for use in the discriminant function were I.Q., high school entrance age, and elementary school grade average.

The multiple biserial R for the three variables was found to be 0.6537. Upon the elimination of the elementary school grade averages from the discriminant function, a multiple biserial R of 0.6304 was obtained. This reduction in the multiple biserial correlation was found to be nonsignificant.

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[1]Ibid. p. 31.

Herdman concluded that when using the I.Q. and entrance age, there was no significant advantage of including elementary school grades in the prediction scheme for predicting high school attrition.

Billharts and Hutson[1] made a study of pupils entering the seventh grade at Pittsburgh, Pa. in the year 1928. Data for the criterion, college quality point average based on 10 semester hours or more of college work, were collected in 1936.

Variables used in the study included quality point averages for junior high school and the intelligence quotient.

When these variables were correlated with the criterion the following Product Moment coefficients of correlation were obtained:

Junior high quality point average	0.561
Intelligence quotient	0.369

The writers concluded

> That college success can be predicted at the end of junior high school as well as at the end of senior high school is a finding of substantial import for guidance programs. The break between the junior and senior high school is as crucial a period for guidance as any in the school career of youth.
>
> Counselors must aid pupils in their choice of the diverse educational highways which confront

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[1] Billharts, W. H. Jr. and Hutson, P. W. Determining College Ability During Junior High School Years. School and Society 53:547-52. April 26, 1941.

> them after junior high school years. To perform this task they need instruments that will enable them to peer into the future and to help pupils estimate their own powers and interests with greater accuracy.
>
> The contribution of this study is one such instrument.[1]

A study by Betts[2] was the only investigation available for review that included triserial correlations.

Triserial correlation values indicate the relationship between a continuously distributed variable and a variable segmented into three categories.

The trichotomous variable used by Betts[3] was the tendency of entering students to survive Chemistry 101 at the Iowa State College. This variable was assumed to be trichotomous as it was divided into the following three categories, i.e., (1) students who receive a passing mark in the course, (2) students who receive a failing mark or transfer to a decelerated course at midterm, and (3) those who drop out of college prior to taking Chemistry.

An adjustment was made in the formula for t that is used for testing significance of biserial r so that he could make tests of significance for his values of triserial r.

In recapitulation of the foregoing literature, most of

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[1] Ibid. p. 550.

[2] Betts, Merle E. Probability of Mortality in First Quarter Chemistry for Students of Agriculture at Iowa State College. Unpublished M.S. Thesis, Ames, Iowa, Iowa State College Library. 1950. p. 19.

[3] Ibid. p. 19.

the studies reviewed have used information that is not available until after graduation from high school.

III. THE COMMUNITY OF FORT DODGE

The city of Fort Dodge is the county seat of Webster County, located in the northwest part of Iowa. The city covers an area of 5.26 square miles, with a population of 25,115.[1] Fort Dodge was established in 1850 as a military outpost and in the past century it has grown into a modern and progressive community.

There are 61 manufacturing concerns in the Fort Dodge area.[2] Nationally known manufactured products produced in the Fort Dodge area include gypsum products, clay products, packinghouse products, animal serums, farm machinery, gloves and mittens, tents and awnings and canvas items, dairy products, bread, butter tubs, shipping containers, signs, hoists, poultry and hog remedies, carbonated beverages, fishing plugs, soybean products, radio parts, mixed feeds, castings, and many other articles.

Fort Dodge has 34 churches representing 21 denominations. There are two hospitals in the city, one of which has an accredited training school for nurses.

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[1] Fort Dodge The Industrial and Shopping Center of Northwest Iowa. Fort Dodge Chamber of Commerce. n.d.

[2] Fort Dodge Industrial Directory. Fort Dodge Chamber of Commerce. n.d.

The city government is of the commission form. A mayor and two commissioners head the city's administration.

In a bulletin entitled "Fort Dodge the Industrial and Shopping Center of Northwest Iowa",[1] the Chamber of Commerce reports on the city of Fort Dodge as follows:

> Fort Dodge, Iowa, a city of some 30,000 people in its corporate limits and immediate environs, occupies one of the most strategic locations in the middle west. Covering an area of 5.26 square miles, with additional areas to be added soon through annexation, the city is built along the natural setting of the beautiful Des Moines River valley. The site of the city is abundantly wooded, making ideal settings for its residential areas.
>
> Fort Dodge's schools include outstanding public and parochial educational facilities through the elementary grades, junior and senior high schools and a fully accredited junior college. Its business and shopping district is unsurpassed and is complete in every detail and its industries are nationally and internationally known for their fine products. Its churches represent all denominations of religious bodies.

The Fort Dodge educational system includes nine public elementary schools, a junior high school, a senior high school, and a junior college. In addition to the public schools, there are three parochial schools, one business college and one school of cosmetology in the city. The public school curriculum offers home economics, industrial arts, and commercial courses, in addition to the usual academic subjects.

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[1] Fort Dodge The Industrial and Shopping Center of Northwest Iowa. Fort Dodge Chamber of Commerce. n.d.

IV. METHOD OF PROCEDURE

There were 434 students enrolled in the ninth grade in Fort Dodge Junior High School in the Fall of 1946 and the Fall of 1947. Of this number, 47 cases were eliminated because of insufficient data, reducing the study to 387 cases.

The students were classified into three groups, i.e., (1) graduates matriculating in college, 128, (2) graduates not matriculating in college, 175, (3) withdrawals for reasons other than transfer, 84.

A college matriculant was defined as any student who entered an accredited college or university. A withdrawal was defined as any pupil who had left school, for reasons other than transfer, without graduating from high school after he had completed ninth grade.

The data for the criterion college matriculation was obtained by telephone calls, questionnaires, or personal interviews. Persons contacted for this information were parent or guardian, close relative, or the high school guidance officer who keeps a follow-up study of recent graduates.

The data taken from the permanent record cards were

withdrawal or graduation from high school, intelligence quotient, and ninth grade mark averages.

Ninth grade mark averages and the intelligence quotient were the variables used in the discriminant function to predict the tendency of students to fall into one of three groups. These groups were (1) college matriculation, (2) high school graduation, and (3) attrition.

Statistical techniques employed in the treatment of the data were triserial r, multiple triserial R, and the discriminant function. Formulas used in the statistical treatment were developed by Wert, Neidt, and Ahmann.[1]

To facilitate statistical treatment the following numerical values were assigned to the usual letter marks: A = 4, B = 3, C = 2, D = 1, and F = 0.

A table of chances in 100 for a student to matriculate in college, to graduate from high school but not matriculate, or to withdraw from school was made by the use of the discriminant function from a combination of the intelligence quotient from the Otis Self-Administering Test and the ninth grade mark average.

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[1] Wert, James E., Neidt, Charles O., Ahmann, J. Stanley. Biserial and Tetrachoric Correlation. Mimeographed manuscript of a chapter in a forthcoming book.

V. PROBABILITY OF COLLEGE MATRICULATION

The triserial correlation technique was developed by Jaspen[1] to indicate the relationship between a continuously distributed variable and a variable segmented into three categories.

This technique was used in this study because of the trichotomous nature of the distribution. These groups were (1) students who graduated from high school and matriculated in college, (2) students who graduated from high school but did not matriculate in college, and (3) students who withdrew from school before graduation.

A. Triserial Correlation

The I. Q. and the ninth grade mark average were used to develop a prediction formula from which a probability table was constructed. This table indicates a pupil's tendency toward continuation of education.

The means of the raw scores for those pupils who were in each of the groups are shown in Table 1.

For the statistical treatment which follows the sums,

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[1] Jaspen, Nathan. Serial Correlation. Psychometrika 11:23-30. 1946.

Table 1

Means of Intelligence Quotients and Ninth Grade Mark Averages For The College, High School, and Attrition Groups

Variable	Symbols	College (N 128)	High School (N 175)	Attrition (84)
Intelligence quotient	X_1	106.625	99.726	97.333
Ninth grade mark averages	X_2	2.471	2.064	1.771

Table 2

Sums, Sums of Squares, and Cross-Products of Raw Data for Each Group

Variable	College	High School	Attrition
ΣX_1	13648.0	17452.0	8176.0
ΣX_2	316.26	361.14	148.70
ΣX_1^2	1469498.0	1750916.0	806984.0
ΣX_2^2	840.0382	806.0088	285.7690
$\Sigma X_1 X_2$	34074.93	36521.08	14739.06

sums of squares, and cross products were used. The values are shown in Table 2.

The relationship between the tendency for continuation of education and either of the variables was expressed by triserial r, which was computed from the formula

$$r = \frac{\Sigma[(z_1 - z_h)\bar{Y}]}{\sigma\Sigma\left[\frac{(z - z)^2}{p}\right]}$$

where

z_1 = height of ordinate at lower end of interval

z_h = height of ordinate at upper end of interval

σ = standard deviation of the continuous variable

p = proportion of the total group in a category.

The standard deviations were 12.5976, and 0.6586 for the intelligence quotients and the ninth grade mark averages respectively.

Additional information necessary for the solution of triserial r will be found in Table 3.

Substituting in the formula for x_1

$$r = \frac{(0.36245)(106.625) + (-0.06861)(99.7237) + (-0.29384)(97.333)}{(12.5976)(0.80537)}$$

$r = 0.31576$

Substituting for x_2

$$r = \frac{(0.36245)(2.47078) + (-0.0681)(2.06366) + (-0.29384)(1.77023)}{(0.65861)(0.80537)}$$

$r = 0.422$

To test whether the triserial r was significantly different from zero, the t-test was employed. The formula was

Table 3

Information Needed for Solution of Triserial r, and Multiple Triserial R

Group	N	p	z	z-z	$\frac{z-z}{p}$	$\frac{(z-z)^2}{p}$	Sums	
							I.Q.	9th Grade Mark Average
College	128	0.3307	0.36245	0.36245	1.0960	0.39725	13648	316.26
High School	175	0.4522		-0.06861	-0.1517	0.01041	17452	361.14
Attrition	84	0.2171	0.29334	-0.29334	-1.3535	0.39771	8176	148.70
Totals	387	1.0000				0.80537	39176	826.10

$$t = \sqrt{\frac{r^2(N-2)}{\frac{1}{\Sigma\left[\frac{(x-\bar{x})^2}{p}\right]} - r^2}}.$$

Substituting for x_1

$$t = \sqrt{\frac{(0.31576)^2\ (385)}{\frac{1}{0.80537} - (0.31576)^2}} = 5.7963.$$

The t-value of 5.7963 was found to be significant beyond the 1 per cent level.

Substituting for x_2

$$t = \sqrt{\frac{(0.422)^2\ (385)}{\frac{1}{(0.80537)} - (0.31576)^2}} = 8.0312.$$

The t-value of 8.0312 was also found to be highly significant.

B. Multiple Triserial Correlation

The discriminant function was used to obtain the best weights to be assigned to intelligence quotients, and ninth grade mark averages. The discriminant function employs the following basic normal equations.

$$\Sigma x_1 y = a_1 \Sigma x^2_1 + a_2 \Sigma x_1 x_2$$

$$\Sigma x_2 y = a_1 \Sigma x_1 x_2 + a_2 \Sigma x^2_2.$$

Necessary values from the original data are as follows:

	Deviation Values
Σx_1^2 (intelligence quotient)	61410.07
Σx_2^2 (ninth grade mark average)	16840.2021
$\Sigma x_1 x_2$	1706.8538
$\Sigma x_1 y$	1244.5236
$\Sigma x_2 y$	90.57057

The deviation values, Σx_1^2, Σx_2^2, and $\Sigma x_1 x_2$ were found in the usual manner. The deviation values $\Sigma x_1 y$ and $\Sigma x_2 y$ were computed from the following formulas.

$$\Sigma x_1 y = \Sigma \left[\left(\frac{\Sigma - \Sigma}{p} \right) \Sigma x_1 \right]$$

Substituting the needed values from Table 3

$$\Sigma x_1 y = (1.0960)(1364.8) - (0.1517)(1745.2) - (1.3535)(8176)$$
$$= 1244.5236.$$

$$\Sigma x_2 y = \Sigma \left[\left(\frac{\Sigma - \Sigma}{p} \right) \Sigma x_2 \right]$$

Substituting the needed values from Table 3

$$\Sigma x_2 y = (1.0960)(316.26) - (0.1517)(361.14) - (1.3535)(148.70)$$
$$= 90.57057.$$

These deviation values were substituted in the simultaneous equations which became:

$$1244.5236 = 61410.07a_1 + 1706.8538a_2$$
$$90.5706 = 1706.8538a_1 + 16840.2021a_2.$$

Solution of the simultaneous equations produced the following discriminant function:

$$v = 0.0074023203x_1 + 0.462808584x_2$$

where

$v = \frac{x}{\sigma}$ score in deviation form

x_1 = deviation intelligence quotient

x_2 = deviation ninth grade mark average.

Computation of multiple triserial correlation for the discriminant function equation was made by using the formula

$$R = \frac{1}{\Sigma\left[\frac{(z - \bar{z})^2}{p}\right]}\sqrt{\frac{\Delta}{N}}$$

where the value of $\left(\frac{z - \bar{z}}{p}\right)^2$ may be taken from Table 3 and where $\Delta = a_1 \Sigma x_1 y + a_2 \Sigma x_2 y$.

Thus $\Delta = (0.0074023203)(1244.5236) + (0.462808584)(90.57057)$

$\Delta = 51.1292$.

Solving for R

$$R = \frac{1}{0.80537}\sqrt{\frac{51.1296}{387}} = .4513.$$

To test the significance from zero of the multiple triserial correlation the following formula was used.

$$F_{m,\ N-m-1} = \frac{\Delta\ (N-m-1)}{\left[N\ \Sigma\left[\frac{(z - \bar{z})^2}{p}\right] - \Delta\right]_m}.$$

Substituting the proper values and solving, an F-value of 25.0528 was found. With 3 and 383 degrees of freedom the

value of 25.0528 was significant far beyond the 1 per cent level. This indicated that there was some evidence that college matriculation can be effectively predicted from intelligence quotients and ninth grade mark averages.

C. Probability of College Matriculation

The discriminant function lends itself to the prediction of some specific probability such as college matriculation. In order to use the discriminant function equation to predict such probabilities it was changed from deviation form to raw score form. The discriminant function in deviation form was

$$v = 0.007402x_1 + 0.46281x_2$$

To change this formula from deviation form to raw score form the following equation was used.

$$V - \bar{V} = a_1 (X_1 - \bar{X}_1) + a_2 (X_2 - \bar{X}_2).$$

Substitution of the proper values gave the equation

$$V + 0.43909 = (0.007402)(X_1 - 106.62) + (0.46281)(X_2 - 2.47)$$

$$V = 0.007402X_1 + 0.46281X_2 - 2.37146.$$

Substitution of the intelligence quotient and ninth grade mark average of any individual in this equation yielded a predicted V in sigma units. This sigma score was converted into probability of college matriculation by use of a normal curve table of unit area.

The prediction was carried further to include the probability of a student graduating from high school but not matriculating to college. To predict this probability the equation becomes

$$V - 0.782025 = (0.007402)(X_1 - 102.64) + (0.46281)(X_1 - 2.235)$$

$$V = 0.007402X_1 + 0.46281X_2 - 1.01213.$$

This equation yielded a predicted V in sigma units which when converted included the student's chances in 100 of matriculating to college. Therefore it was necessary to subtract this figure from the total so that his chances of graduating from high school, but not matriculating in college, could be determined.

In order to obtain the student's probability of withdrawing from school before graduation, the total of the first two predictions had to be subtracted from 100. The remainder being his chances in 100 of withdrawing from high school before graduating. Table 4 was constructed using various intelligence quotients and various ninth grade mark averages. An example of the use of Table 4 follows. A particular student has an intelligence quotient of 110 and a ninth grade mark average of 2.50. This pupil has 34 chances in 100 of graduating from high school and matriculating in college, 49 chances in 100 of graduating from high school but not matriculating in college, and 17 chances in 100 of withdrawing from a school before graduation.

Table 4

Chances in 100 of Continuation of Education
Based on Otis I.Q. and 9th Grade Average Mark

9th Grade Mark Ave.	Group	Otis Intelligence Quotient							
		70	80	90	100	110	120	130	140
4.00	College	50	53	56	59	62	64	67	70
	High Sch.	41	39	37	35	33	32	29	27
	Attrition	9	8	7	6	5	4	4	3
3.50	College	41	44	46	49	52	55	57	60
	High Sch.	46	44	44	42	40	38	37	35
	Attrition	13	12	10	9	8	7	6	5
3.00	College	32	35	38	40	43	46	49	52
	High Sch.	49	48	47	47	45	44	42	40
	Attrition	19	17	15	13	12	10	9	8
2.50	College	24	27	30	32	34	37	40	43
	High Sch.	51	50	49	49	49	48	47	44
	Attrition	25	23	21	19	17	15	13	13
2.00	College	18	20	22	24	26	29	31	34
	High Sch.	49	49	50	50	51	50	50	49
	Attrition	33	31	28	26	23	21	19	17
1.50	College	13	14	16	17	19	22	24	26
	High Sch.	45	47	48	49	50	50	50	50
	Attrition	42	39	36	34	31	28	26	24
1.00	College	8	9	11	12	14	15	17	19
	High Sch.	41	43	44	46	46	48	49	50
	Attrition	51	48	45	42	40	37	34	31
0.50	College	5	6	7	8	9	11	12	13
	High Sch.	54	53	52	51	51	49	48	47
	Attrition	41	41	41	41	40	40	40	40

VI. SUMMARY

The purpose of the study was to derive a prediction formula for determining the probability of a graduate of Fort Dodge High School matriculating in college.

Information was tabulated from permanent record cards in the Fort Dodge High School, from telephone conversations, from questionnaires, and from the High School guidance officer. The prediction was made from 128 pupils who matriculated in college, 175 pupils who graduated from high school but did not matriculate in college, and 84 pupils who withdrew from high school before graduating.

The triserial r-values of the relationship of the tendency for educational continuation to the intelligence quotient and to the ninth grade mark averages were 0.3157, and 0.422 respectively. Each of these values was highly significant.

The discriminant function using a combination of intelligence quotients and ninth grade mark averages as prediction variables yielded a multiple triserial correlation of 0.4513. This value was significant at the 1 per cent level and indicated that these variables are useful in forecasting educational continuation.

A probability table was constructed using the two foregoing variables to predict the chances in 100 of graduating from high school and matriculating in college, graduating from high school but not matriculating in college, and withdrawing from high school before graduation. The prediction equations used were

$$V_c = 0.007402X_1 + 0.46281X_2 - 2.37146$$

and

$$V_{chs} = 0.007402X_1 + 0.46281X_2 - 1.01213$$

where

X_1 = intelligence quotient

X_2 = ninth grade mark average.

From the foregoing equations a probability table was constructed showing the chances in 100 of a pupil continuing in formal education.

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